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CHRONIC UNDERNUTRITION AND ADOLESCENT SCHOOL PERFORMANCE IN CENTRAL ETHIOPIA

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ABSTRACT

Chronic undernutrition among adolescents in developing countries has been identified as a major public health issue. Previous research has found associations between chronic undernutrition and academic performance outcomes in adolescents. There is need for localized research focusing on nutritional status and its association with educational outcomes among adolescents in different areas of Ethiopia. The purpose of this study was to examine whether chronic undernutrition (stunting) in adolescents in Ethiopia was correlated with various school performance outcomes. This study was a school-based cross-sectional study conducted in North Shewa zone, Ethiopia. Data were collected through a structured questionnaire. The researchers conducted multivariable linear regression analyses to investigate the relationship between stunting and four school performance outcomes, which included grade 8 Ministry exam score, all-subjects average score, English score, and Math score. The prevalence of stunting in this sample was 11%. After adjusting for all other variables in the model, stunting was positively associated with the grade eight Ministry exam score (β = -4.96; 95% [CI -7.68, -2.25]; $p < 0.001$). In the multivariate analyses, sex (being female) was significantly associated with the grade eight Ministry exam score (β = -2.08; 95% CI [-3.81, -0.35]; $p = 0.019$), the all-subjects average score (β = -3.97; 95% CI [-5.51, -2.43]; $p < 0.001$), English score (β = -3.72; 95% CI [-5.60, -1.84]; $p < 0$ .001), and Math score (β = -4.87; 95% CI [-7.02, -2.72]; $p < 0.001$). Residence (living in a rural area) was significantly associated with all-subjects average score (β = -3.93; 95% CI [-5.81, -2.06]; $p < 0.001$), English score (β = -2.65; 95% CI [-4.94, -0.35]; $p = 0.024$), and Math score (β = -3.86; 95% CI [-6.50, -1.22]; $p = 0.004$). Maternal education (grade 1-8) was significantly associated with English score (β = 5.46; 95% CI [1.31, 9.62]; $p = 0.010$) and Math score (β = 4.78; 95% CI [0.03, 9.53]; $p = 0.049$). These findings indicate that further research focusing on adolescent chronic undernutrition and educational outcomes as well as why chronic undernutrition is associated with certain performance outcomes and not others is needed before definitive conclusions can be made. Positive changes in child growth later in a child's life may have important implications for cognition.

Key words: Adolescent health, Central Ethiopia, undernutrition, stunting, academic performance

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INTRODUCTION

Sufficient and nutrient-rich food in early childhood is necessary for proper growth and cognitive development among children and adolescents [1]. Infancy and early childhood contain critical periods of brain formation that serve as a foundation for cognitive and socio-emotional skill development throughout life [2]. Undernutrition in infancy and early childhood can have lasting adverse effects and can lead to stunting, an indicator of chronic undernutrition [3]. Stunting is of particular concern in Ethiopia. While Ethiopia has experienced notable economic growth over the past decade and has made remarkable progress towards most of the targets of the health-related millennium development goals (MDGs), including a substantial reduction in prevalence of stunting in children under five (CU5), it still remains one of the world's least developed countries [4]. Stunting in early childhood often persists into adolescence, which can have significant consequences for economic and educational productivity at the individual, household, and community levels [5, 6]. Thus, chronic undernutrition and its role in academic performance and outcomes remain a major public health concern in Ethiopia.

Cross-sectional studies of stunted school-aged children compared to non-stunted school-aged children have found associations between concurrent stunting and poor school performance and cognitive ability, including less likely to be enrolled in school, more likely to enroll late, more likely to have lower grades for their age, and more likely to have poorer achievement scores [6, 7, 8]. Additionally, a school-based cross-sectional study from southwest Ethiopia found that stunting was associated with lower academic performance compared to children who were not stunted [9]. Furthermore, students with educated parents were more likely to achieve good academic performance compared to students with less educated parents [9]. Similar results were found in western Ethiopia, where students who were stunted were less likely to have good academic performance than their counterparts [10].

Another study in northwest Ethiopia found that stunting was significantly positively associated with academic achievement of students, after controlling for factors such as age, mother's education, monthly income, and absenteeism [11]. Another study, however, found no significant association between stunting and academic performance in southern Ethiopia but instead found that grade repetition, living in rural areas, student class rank, and class absenteeism were significantly associated with academic performance [12]. Such adverse associations between stunting and cognitive function and school performance point to stunting as an important indicator of children and adolescents' potential ability to reach their full potential, secure future job and income opportunities, and perpetuate or leave the cycle of poverty.

The prevalence of stunting among adolescents in Ethiopia varies depending on the region with estimates ranging from 7.2% to 48.1% [9, 13, 18]. Many estimates of stunting focus solely on adolescent girls. While Ethiopia has demonstrated progress in addressing undernutrition over the past several decades, studies conducted locally in Ethiopia have demonstrated that the prevalence of stunting among adolescents remains high, and that chronic undernutrition among adolescents is still a major public health

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issue [19]. Furthermore, because adolescents typically have lower rates of infectious and chronic diseases than CU5 and global nutrition initiatives tend to focus on either CU5 or, more recently, on the first 1000 days of life, there is a lack of research on adolescent nutrition and wellbeing in developing countries [19]. Although studies have been done on the local level in many areas, there remains room for further exploration of adolescent nutrition status and school performance in central Ethiopia, particularly given the cultural diversity of different areas of Ethiopia. Given the demonstrated adverse associations of chronic undernutrition with poor academic performance in some developing countries and the need for more localized research in Ethiopia, we conducted a school-based cross-sectional study aimed at assessing the association between stunting and school performance in central Ethiopia.

MATERIALS AND METHODS

Study Area

This study was a school-based cross-sectional study conducted in Fitche town in North Shewa zone, Ethiopia, which is located about 112 km from the capital city of Addis Ababa. Figure 1 displays the study location in Ethiopia. The data were collected over a one-month period in 2017.

Figure 1: Study Site in Ethiopia

Study Population

The study population included students in grades nine and 10 who were attending two secondary schools in the study area. Inclusion criteria included being between 14 and 19 years old, being in grades nine or 10, attendance at one of the two secondary schools for at least three consecutive semesters, and residence in the Fitche town or around the

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semi urban area for at least six months. Exclusion criteria included students who did not attend the selected schools for the most recent semester or students who reported being chronically ill or seriously sick.

Sample Size Determination
The sample size required for this study was calculated using a single population proportion formula with the assumption of a 95% confidence interval, 5% margin of error, 10% for non-response, and a design effect of two. The formula used to calculate the sample size is provided below, where n is the required sample size, $Z\alpha/2$ is the critical value for normal distribution at 95% confidence interval, p is the established proportion from previous studies of the topic of interest, and d is the margin of error. The prevalence of stunting was estimated to be 30.7% from a study done in a similar area [20]. Accordingly, the final sample size was calculated as 724.

$$n = [\left(\frac{Z\alpha}{2}\right)^2 \frac{p(1-p)}{d^2}]$$

Sampling Procedure
Participants were selected using a multistage sampling procedure. There were two secondary schools in Fitche town. Both schools were selected for sampling, and the grades were stratified into two grades: nine and 10. The number of study participants were selected using probability proportional to population size from each grade, generating a registry for each grade from both schools. Participants were then randomly selected from the registry to generate the final sample. A sampling schema is provided in figure 2.

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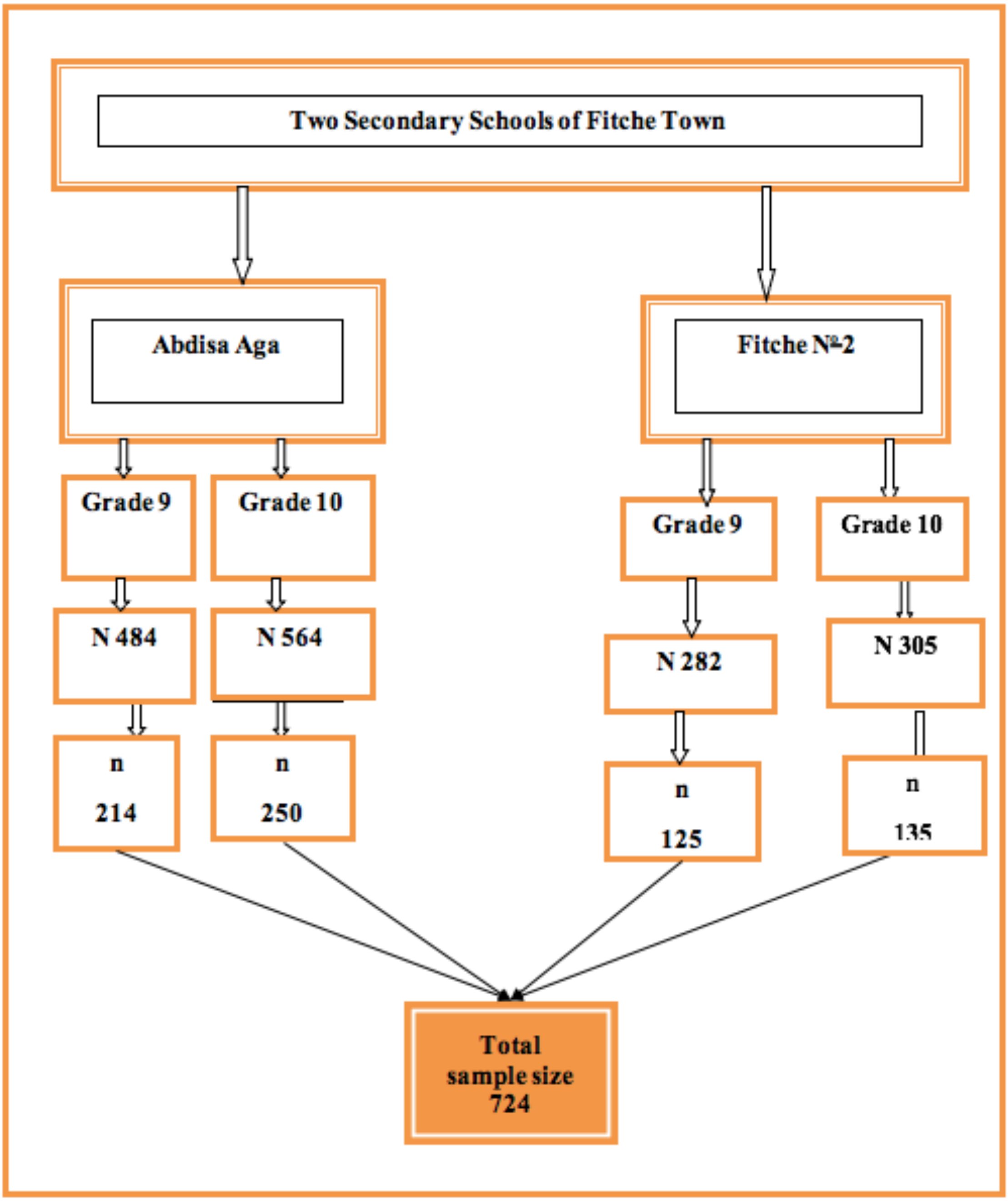

Figure 2: Sampling Schema

Data Collection and Measurements

This was an institutional-based cross-sectional study design where trained data collectors administered a structured questionnaire to participants in the local language (Afaan Oromo). Participant responses were recorded on the questionnaire by the data collectors. Anthropometric measurements of the participants were taken by trained nurses. Height was measured with a Portable Height Scale to the nearest 0.1 cm. Body weight was measured using the platform (digital scale) weighing scale (SECA) to the nearest 0.1 kg. Two consecutive measurements were taken for each anthropometric measurement (height and weight) for each participant. If there were wide variations in

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measurements, supervisors made final validations on site. The participants were weighed with minimum clothing. A height-for-age *Z*-score (HAZ) that was more than two standard deviations below the World Health Organization (WHO) Child Growth Standards Median of the reference population was classified as stunted [21].

Data Quality Control

During data collection two supervisors and ten data collectors received a two-day intensive training on methods of data collection. A pretest was conducted on 5% of the sample size in another school that was outside of the study area. The weight scales were calibrated every morning with known one kilogram weighing materials. Supervisors checked the data collection process and filled questionnaires on a daily basis to ensure accuracy of the data.

Data Analysis

Data were secured through Haramaya University. The data were loaded, cleaned, and analyzed using SAS software version 9.4 [22]. Assumptions of linearity, normality, and constant variance were checked. Data were also checked for missing values and outliers. Bivariate analyses were carried out for each school performance outcome. Variables that were significant at p-value < 0.2 in the bivariate linear regression were candidates for entering into the multivariable linear regression. To identify the predictors of each school performance outcome, multivariable linear regression models were developed and analyzed for each outcome. Results of the linear regression models are presented as β-coefficients with 95% confidence intervals and p-values. Statistical significance was defined as $P < 0.05$.

In testing for association between stunting and academic performance outcomes in this dataset, potential confounders were identified based on a literature review of factors associated with both stunting and school performance outcomes. Thus, variables assessed as confounders included age, sex, residence, ethnicity, dietary diversity score, maternal education, paternal education, and wealth index. Sex was classified as male or female. Residence was classified as living in an urban or rural area. Ethnicity was classified as Oromo or Amhara. There were four individuals classified as "other" ethnicity, representing 0.005% of the sample. These individuals who were "other" ethnicity were removed because of the small sample size in this group, and ethnicity had a non-linear trend when these individuals were considered. This resulted in a final sample of 720 participants for analysis. The wealth index was developed based on terciles within the sample population, thus classified as one (low), two (medium), or three (high).

Dietary diversity data were collected using 24-hour dietary intake recall, which collected information on dietary consumption in the past 24 hours and was based on the Food and Agriculture Organization of the United Nations' (FAO) guidelines for measuring household dietary diversity. This information was used to calculate the dietary diversity score (DDS). The FAO's guidelines include 12 food groups: cereals; white tubers and roots; vegetables (combination of vitamin A rich vegetables and dark green, leafy vegetables); fruits (combination of vitamin A rich fruits and other fruits); meat (combination of eggs; fish and other seafood; legumes, nuts, and seeds; milk and

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milk products; oils and fats; spices, condiments, and beverages; and sweets [23]. For this study, the sum of food groups reported as consumed was calculated for each participant, and the mean was identified for the study population. A new variable was created and each participant was assigned a value 0/1, indicating having a dietary diversity score that was below or above the mean. This dichotomous variable was used in analysis.

This study examined four school performance outcomes, including the grade 8 Ministry examination score, English language score, Math score, and the all-subjects average score. The grade 8 Ministry examination was an end-term exam based on the curriculum designed by the Ministry of Education in Ethiopia. A minimum score of 40 was needed to pass onto grade nine. The all-subjects average score was the average exam score across all of the subjects taught in the school. The English language and Math scores were selected because they are subjects that all students enrolled in the schools in the study area were required to take, and they best represent the extent of the students' development of literacy and numeracy skills. The highest possible score for all exams was 100. All dependent variables were assessed as continuous variables.

Ethical Considerations
This study obtained ethical clearance from the Institutional Health Research Ethics Committee of Haramaya University. Data were collected from the students and their rosters after obtaining informed voluntary written and signed consent from the Zonal Education Department and Director of the School. Confidentiality of the information and privacy were secured during data collection and analysis.

RESULTS AND DISCUSSION

Sample Characteristics
A total of 720 participants were included in the analysis. Descriptive statistics are presented in Table 1. The mean age of the sample was 17.3 years with a standard deviation of 0.9. Males made up 42.8% of the participant population. A majority of the population (92.8%) were Orthodox Christian, while 6.5% were Protestant, and 0.6% were Muslim. Regarding ethnicity, 74.4% of participants were Oromo and 25.4% were Amhara. Because the wealth index was generated using binned terciles, 33.3% of participants were categorized as having a low wealth index, 34.5% a medium wealth index, and 32.2% a high wealth index. The mean DDS was 5.41 with a standard deviation of 1.595, with 56.1% of participants having a low DDS. Regarding ASF consumption, 98.9% of participants had not consumed any ASF in the past 24 hours. The mean (SD) HAZ was -0.95 (0.92). The prevalence of stunting in this sample was 11%.

Grade 8 Ministry Exam Score
Results from the regression analyses for the grade 8 Ministry exam score are shown in Table 2. In the multivariate analysis, after adjusting for all other variables in the model, age was positively associated with the grade 8 Ministry exam score, while stunting and being female were negatively associated with grade 8 Ministry exam score.

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All-Subjects Average Score

Results from the regression analyses for the all-subjects average score are shown in Table 3. In the multivariate analysis, after adjusting for all other variables in the model, being female and living in a rural area were negatively associated with the all-subjects average score.

English Score

Results from the regression analyses for English score are shown in Table 4. In the multivariate analysis, after adjusting for all other variables in the model, age, being female, living in a rural area, and having a medium wealth index were negatively associated with English score, while a maternal education of grades 1-8 was positively associated with English score.

Math Score

Results from the regression analyses for the math score are shown in Table 5. In the multivariate analysis, after adjusting for all other variables in the model, being female and living in a rural area were negatively associated with Math score, while being Amharic and maternal education of grades 1-8 were positively associated with Math score.

The findings of this study show that the prevalence of stunting in this sample was 11%. These findings are lower than estimates from Hawa Gelan district in southwest Ethiopia, where the prevalence of stunting was 20.6% [9], but slightly higher than estimates from Addis Ababa in central Ethiopia, where the prevalence of stunting was 7.2% [13]. The data from this study were collected in central Ethiopia near the capital, Addis Ababa. This may help explain the lower prevalence of stunting in relation to other studies in Ethiopia, as living closer to a large urban area generally means better access to markets, schools, and work. People who live closer to urban areas also have better access to health services and are generally more easily reached by health and educational campaigns and interventions than people who live in rural areas [17].

The results of this study show that stunting was significantly associated with the grade 8 Ministry exam score in the multivariate analysis. Those who were stunted had significantly lower grade 8 Ministry exam scores than those were not stunted. Similar results were found in Asmare *et al*. [11], where stunting had significant positive associations with academic performance among students in northwest Ethiopia. Similarly, Seyoum *et al*. [10] found that stunted children in western Ethiopia were less likely to have good academic performance after controlling for various sociodemographic variables. These results point to the fact that stunting better reflects the accumulation of inadequate nutrition over a child's life, which may then affect the cognitive performance and educational achievement of school-aged children [9].

The results of this study indicate that poor school performance among adolescents in this sample was multi-factorial. While nutritional interventions during the first 1000 days of life are critical to prevent malnutrition, school-aged children and adolescents represent a potentially beneficial target point for nutritional interventions as positive changes in an adolescent's growth may have important implications for cognitive

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development. Previous results have suggested that adolescence may be another critical window of opportunity to promote growth in addition to the first 1000 days of life [24]. A focus on adolescent health could be especially beneficial for young women and girls in addressing intergenerational undernutrition, as better nutrition during pregnancy is critical for infant health outcomes [24]. Nutrition interventions during school-aged years (5-18 years old) are not without their benefits and may have value for growth and development [24, 25, 26]. Positive changes in child growth later in a child's life may have important implications for cognition and school performance outcomes [25].

Sex was the only variable that was significantly associated with all of the school performance outcomes, with females scoring significantly lower on the school performance exams compared to males when controlling for all other variables. While Ethiopia has made significant progress over the past two decades towards achieving universal primary education, the school systems are still navigating complex environments, where institutional norms may reinforce gender biases that favor boys' education, and factors such as poverty, prohibitive school fees and cost of educational materials, the safety of traveling conditions and the school environment for girls, the possibility of early marriage, and gender-specific roles for domestic responsibilities may leave girls at a disadvantage with school attendance and performance outcomes [27]. Ethiopia has made progress in closing the gender gap in education and in establishing health extension services for women and girls in *kebeles*; however, national-level research and statistics often miss the local-level variation in gender norms that shape girls' lives [28]. Gender norms "intersect with structural disadvantages" (such as poverty and living in rural areas with limited access to goods and services) to affect both girls and boys, generating different types of inequalities in both girls' and boys' health and education outcomes [29]. Research that aims to understand differences in local contexts is key to unpacking the specific issues and vulnerabilities that both girls and boys face and to shaping programs and policies to address them on a *woreda* and *kebele* level [28].

Multivariate linear regression analyses also showed that a higher maternal education was significantly associated with English and Math scores. Previous research has connected parental education with children's cognitive development through increased access to resources, improved parenting skills and growth-related knowledge, increased cognitive stimulation of children, and lower incidence of maternal depression and stress [25, 30]. Maternal education, specifically, has been associated with a variety of preventative and treatment-oriented behaviors, including reproductive behaviors (such as delaying childbearing), exclusive breastfeeding practices, increased health care service utilization, and improved access to information and health knowledge [31], [32]. Higher maternal educational attainment may also facilitate more work opportunities and economic potential that can provide a source of income for women, expand and strengthen social networks, and increase resources available to women and their families [31]–[33]. These pathways by which maternal education may lead to improved child educational and nutritional outcomes reflect a result of cumulative and complex processes of maternal behaviors that intersect with economic, political, and social structures and processes to positively contribute to child schooling and health outcomes [31].

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This study has some limitations. This was a cross-sectional study design, which represents a snapshot in time. Causality and time-order of variables cannot be established. Additionally, there is the possibility of self-report bias. This study measured academic performance through various test scores. A combination of test scores and robust measures of cognitive performance that are validated across different cultural, ethnic, and socioeconomic groups, such as the Kaufman Assessment Battery for Children or Raven's Colored Progressive Matrices [34, 35], should be considered for future research on undernutrition and school performance.

CONCLUSION

This study showed that the prevalence of stunting in this sample was 11%. Although these data do not entirely support the hypothesis that stunting in adolescents is predictive of school performance, neither do they completely refute it. The findings indicate that further exploration of adolescent undernutrition and educational outcomes and why nutritional indicators are associated with certain educational outcomes and not others are needed before definitive conclusions can be made. Chronic undernutrition may be the mechanism by which other health issues affect cognition and health outcomes. This study underscores the need for longitudinal, randomized controlled trials to better understand the potential impact of chronic undernutrition on educational outcomes in adolescents. Improving nutritional status may have both critical educational and health benefits for adolescents.

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CONFLICT OF INTEREST
The authors declare there is no conflict of interest.

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Table 1: Descriptive statistics of the sample (*n* = 720)

Characteristic	N (%)
Age, mean years (SD)	17.3 (0.90)
DDS, mean (SD)	5.4 (1.60)
HAZ, mean (SD)	-0.95 (0.92)
Grade 8 Ministry exam score, mean (SD)	63.1 (11.7)
Stunting, *N* (%)	
Not Stunted	644 (89.0)
Stunted	80 (11.0)
Sex, *N* (%)	
Male	310 (42.8)
Female	414 (57.2)
Residence, *N* (%)	
Urban	520 (71.8)
Rural	204 (28.2)
Ethnicity, *N* (%)	
Oromo	536 (74.4)
Amhara	184 (25.6)
Wealth Index, *N* (%)	
Low	241 (33.3)
Medium	250 (34.5)
High	233 (32.2)
Maternal Education	
Unable to read and write	516 (73)
Able to read and write	116 (17)
Grades 1-8	72 (10)
Paternal Education	
Unable to read and write	454 (64)
Able to read and write	128 (18)
Grades 1-8	125 (18)
Categorized Dietary Diversity Score (DDS)	404 (56.1)
Low	316 (43.9)
High	
ASF Consumption	
No	712 (98.9)
Yes	8 (1.1)

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Table 2: Bivariate and multivariate analyses of variables associated with grade 8 Ministry exam score

Characteristic	Bivariate		Multivariate	
	β (95% CI)	*P*-value	β (95% CI)	*P*-value
Stunting				
Not Stunted	0.00		0.00	
Stunted	-5.34 (-8.03, -2.64)	< 0.001	-4.96 (-7.68, -2.25)	<0.001[a]
Age (years)	1.39 (0.47, 2.30)	0.003	1.32 (0.35, 2.28)	0.008[a]
Sex				
Male	0.00		0.00	
Female	-2.42 (-4.14, -0.70)	0.006	-2.08 (-3.81, -0.35)	0.019[a]
Residence				
Urban	0.00			
Rural	-0.15 (-2.05, 1.75)	0.876		
Ethnicity				
Oromo	0.00		0.00	
Amhara	-1.61 (-3.56, 0.35)	0.108	-1.09 (-3.06, 0.88)	0.277
DDS				
Low	0.00			
High	0.19 (-1.54, 1.92)	0.828		
Wealth Index				
Low	0.00		0.00	
Medium	-2.61 (-4.68, -0.53)	0.014	-1.94 (-4.05, 0.18)	0.072
High	-1.17 (-3.28, 0.93)	0.275	-0.98 (03.31, 1.36)	0.412
Maternal Education				
Unable to read & write	0.00		0.00	
Able to read & write	0.56 (-1.80, 2.92)	0.640	1.35 (-1.09, 3.78)	0.278
Grade 1-8	2.39 (-0.49, 5.28)	0.104	3.00 (-0.11, 6.11)	0.059
Paternal Education				
Unable to read & write	0.00			
Able to read & write	-1.36 (-3.66, 0.93)	0.241		
Grade 1-8	0.84 (-1.48, 3.16)	0.478		

[a]Indicates *P*-value < 0.05

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Table 3: Bivariate and multivariate analyses of variables associated with all-subjects average score

Characteristic	Bivariate		Multivariate	
	β (95% CI)	*P*-value	β (95% CI)	*P*-value
Stunting				
Not Stunted	0.00		0.00	
Stunted	0.46 (-1.97, 2.89)	0.712	0.41 (-1.98, 2.80)	0.736
Age (years)	-1.08 (-1.90, -0.26)	0.010	-0.69 (-1.54, 0.15)	0.109
Sex				
Male	0.00		0.00	
Female	-3.36 (-4.89, -1.84)	<0.001	-3.97 (-5.51, -2.43)	<0.001[a]
Residence				
Urban	0.00		0.00	
Rural	-4.09 (-5.76, -2.43)	<0.001	-3.93 (-5.81, -2.06)	<0.001[a]
Ethnicity				
Oromo	0.00		0.00	
Amhara	1.79 (0.05, 3.54)	0.044	1.38 (-0.37, 3.12)	0.121
DDS				
Low	0.00			
High	0.79 (-0.75, 2.33)	0.312		
Wealth Index				
Low	0.00		0.00	
Medium	-0.05 (-1.88, 1.78)	0.957	-1.58 (-3.50, 0.34)	0.106
High	3.44 (1.58, 5.31)	<0.001	-0.01 (-2.25, 2.24)	0.994
Maternal Education				
Unable to read & write	0.00		0.00	
Able to read & write	1.71 (-0.37, 3.80)	0.108	-0.85 (-3.14, 1.44)	0.467
Grade 1-8	5.15 (2.59, 7.70)	<0.001	2.14 (-1.25, 5.54)	0.215
Paternal Education				
Unable to read & write	0.00		0.00	
Able to read & write	2.95 (0.93, 4.97)	0.004	1.82 (-0.33, 3.97)	0.097
Grade 1-8	4.79 (2.75, 6.83)	<0.001	1.40 (-1.41, 4.22)	0.323

[a]Indicates *P*-value < 0.05

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Table 4: Bivariate and multivariate analyses of variables associated with English score

Characteristic	Bivariate		Multivariate	
	β (95% CI)	*P*-value	β (95% CI)	*P*-value
Stunting				
Not Stunted	0.00		0.00	
Stunted	0.25 (-2.74, 3.23)	0.871	0.49 (-2.43, 3.42)	0.741
Age (years)	-2.28 (-3.27, -1.28)	<0.001	-1.76 (-2.80, -0.73)	<0.001[a]
Sex				
Male	0.00		0.00	
Female	-3.09 (-4.97, -1.21)	<0.001	-3.72 (-5.60, -1.84)	<0.001[a]
Residence				
Urban	0.00		0.00	
Rural	-3.82 (-5.88, -1.76)	<0.001	-2.65 (-4.94, -0.35)	0.024[a]
Ethnicity				
Oromo	0.00			
Amhara	1.25 (-0.89, 3.40)	0.252		
DDS				
Low	0.00			
High	0.96 (-0.93, 2.85)	0.920		
Wealth Index				
Low	0.00		0.00	
Medium	-1.15 (-3.38, 1.09)	0.313	-2.35 (-4.70, -0.01)	0.049[a]
High	4.80 (2.54, 7.07)	<0.001	0.62 (-2.13, 3.36)	0.659
Maternal Education				
Unable to read & write	0.00		0.00	
Able to read & write	2.04 (-0.50, 4.58)	0.115	-0.70 (-3.50, 2.10)	0.625
Grade 1-8	9.06 (5.95, 12.17)	<0.001	5.46 (1.31, 9.62)	0.010[a]
Paternal Education				
Unable to read & write	0.00		0.00	
Able to read & write	3.31 (0.85, 5.78)	0.009	2.33 (-0.29, 4.96)	0.081
Grade 1-8	7.01 (4.52, 9.50)	<0.001	1.43 (-2.03, 4.88)	0.417

[a]Indicates *P*-value < 0.05

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Table 5: Bivariate and multivariate analyses of variables associated with Math score

Characteristic	Bivariate		Multivariate	
	β (95% CI)	*P*-value	β (95% CI)	*P*-value
Stunting				
Not Stunted	0.00		0.00	
Stunted	-1.30 (-4.67, 2.06)	0.447	-1.03 (-4.40, 2.33)	0.546
Age (years)	0.70 (-0.44, 1.83)	0.229		
Sex				
Male	0.00		0.00	
Female	-4.19 (-6.30, -2.07)	<0.001	-4.87 (-7.02, -2.72	<0.001[a]
Residence				
Urban	0.00		0.00	
Rural	-3.88 (-6.21, -1.55)	0.001	-3.86 (-6.50, -1.22)	0.004[a]
Ethnicity				
Oromo	0.00		0.00	
Amhara	2.85 (0.44, 5.27)	0.021	2.51 (0.06, 4.96)	0.045[a]
DDS				
Low	0.00			
High	0.53 (-1.60, 2.66)	0.628		
Wealth Index				
Low	0.00		0.00	
Medium	1.71 (-0.85, 4.27)	0.190	0.37 (-2.32, 3.06)	0.788
High	3.37 (0.77, 5.97)	0.012	0.08 (-3.06, 3.23)	0.958
Maternal Education				
Unable to read & write	0.00		0.00	
Able to read & write	3.08 (0.19, 5.97)	0.037	1.56 (-1.63, 4.76)	0.337
Grade 1-8	6.40 (2.86, 9.94)	<0.001	4.78 (0.03, 9.53)	0.049[a]
Paternal Education				
Unable to read & write	0.00		0.00	
Able to read & write	0.93 (-1.88, 3.75)	0.516	-0.93 (-3.95, 2.10)	0.547
Grade 1-8	4.67 (1.83, 7.51)	0.001	0.11 (-3.85, 4.08)	0.956

[a]Indicates *P*-value < 0.05

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